X-ray Standing-wave Investigations of Valence-electronic Structure

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We have examined the valence-electron emission from Cu, Ge, GaAs, InP, and NiO single crystals under the condition of strong x-ray Bragg reflection; i.e., in the presence of the spatially modulated x-ray standing-wave interference field that is produced by the superposition of the incident and reflected x-ray beams. These crystals span the entire solid-state bonding range of metallic, covalent, and ionic. It is demonstrated that the valence-electron emission is closely coupled to the atomic cores, even for states close to a metallic Fermi edge. Using the bond-orbital approximation, the x-ray standing-wave structure factor for valence-electron emission is derived in terms of the bond polarities and photoionization cross sections of the atoms within the crystalline-unit cell. Additionally, we demonstrate that by exploiting the spatial dependence of the electric-field intensity under Bragg condition, site-specific valence-electronic structure may be obtained.